PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classificati n 6 : B41M 7/00, B41J 2/17 — A1

(11) International Publicati n Number: **WO 97/01449**

(43) International Publication Date: 16 January 1997 (16.01.97)

(21) International Application Number: PCT/GB95/02517

(22) International Filing Date: 24 October 1995 (24.10.95)

(30) Priority Data:
9513096.9 27 June 1995 (27.06.95) GB

(71) Applicants *(for all designated States except US)*: ILFORD A.G. [CH/CH]; Industriestrasse 15, CH-1701 Fribourg (CH). MATTHEWS, Richard, Nordan [GB/GB]; Ilford Limited, Town Lane, Mobberley, Knutsford, Cheshire WA16 7JL (GB).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: SCHÄR, Meinrad [CH/CH]; Chemin Croix-Blanche 26, CH-1731 Ependes (CH). GERVAIS, Fernand [CH/CH]; Eichenweg 12, CH-1735 Giffers (CH). MAUDONNET, Pierre [CH/CH]; CH-1724 Oberried (CH).

(74) Agent: MATTHEWS, Richard, Nordan; Ilford Limited, Town Lane, Mobberley, Knutsford, Cheshire WA16 7JL (GB).

(81) Designated States: AU, BR, CA, CN, CZ, FI, JP, MX, NZ, PL, RU, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

(54) Title: POST-PRINTING TREATMENT OF INK-JET GENERATED IMAGES

(57) Abstract

There is described a method of treating a coated ink receiving sheet after it has been ink-printed which comprises directing on to the ink receiving sheet a stream of steam at a temperature of 100 °C or over and for between 0.1 to 100 seconds under such conditions that only minimum condensation of water occurs on the surface of the ink receiving sheet. In a preferred method, after the sheet has been steam-treated, there is directed on to it heat for between 0.1 and 100 seconds so that the surface temperature of the sheet is between 60 °C and 150 °C.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AM	Armenia	**GB**	United Kingdom	**MW**	Malawi
AT	Austria	**GE**	Georgia	**MX**	Mexico
AU	Australia	**GN**	Guinea	**NE**	Niger
BB	Barbados	**GR**	Greece	**NL**	Netherlands
BE	Belgium	**HU**	Hungary	**NO**	Norway
BF	Burkina Faso	**IE**	Ireland	**NZ**	New Zealand
BG	Bulgaria	**IT**	Italy	**PL**	Poland
BJ	Benin	**JP**	Japan	**PT**	Portugal
BR	Brazil	**KE**	Kenya	**RO**	Romania
BY	Belarus	**KG**	Kyrgystan	**RU**	Russian Federation
CA	Canada	**KP**	Democratic People's Republic of Korea	**SD**	Sudan
CF	Central African Republic			**SE**	Sweden
CG	Congo	**KR**	Republic of Korea	**SG**	Singapore
CH	Switzerland	**KZ**	Kazakhstan	**SI**	Slovenia
CI	Côte d'Ivoire	**LI**	Liechtenstein	**SK**	Slovakia
CM	Cameroon	**LK**	Sri Lanka	**SN**	Senegal
CN	China	**LR**	Liberia	**SZ**	Swaziland
CS	Czechoslovakia	**LT**	Lithuania	**TD**	Chad
CZ	Czech Republic	**LU**	Luxembourg	**TG**	Togo
DE	Germany	**LV**	Latvia	**TJ**	Tajikistan
DK	Denmark	**MC**	Monaco	**TT**	Trinidad and Tobago
EE	Estonia	**MD**	Republic of Moldova	**UA**	Ukraine
ES	Spain	**MG**	Madagascar	**UG**	Uganda
FI	Finland	**ML**	Mali	**US**	United States of America
FR	France	**MN**	Mongolia	**UZ**	Uzbekistan
GA	Gabon	**MR**	Mauritania	**VN**	Viet Nam

Post-Printing Treatment of Ink-jet Generated Images

The present invention relates to a post-printing treatment of ink-jet generated images. Ink-jet images generated at the present time have a particular need for improvement in their handling properties. They should be smear resistant. This means that the recorded image should remain intact after rubbing the surface with a slightly wet finger. The dyes should remain in their original positions. Very often a small quantity of dye does not penetrate into the ink receiving sheet but is deposited on the surface of the ink receiving sheet. This surface dye is easily displaced mechanically which results in a soiled image. The presence of surface due can in many cases be seen when looking at the image under a low angle. The surface dye may alter the reflection properties of the surface. Depending on the viewing angle the image colour may change.

The present invention provides a solution towards this problem of smudge resistance.

Ink-jet printing systems generally are of two types: continuous stream and drop-on-demand. In continuous stream ink-jet systems the continuously emitted ink droplets are charged in accordance with digital data signals and passed through a static electric field which adjusts the trajectory of each droplet in order to direct it to a gutter or to a specific location on a recording medium. In drop-on-demand systems a droplet is expelled from an orifice to a position on a recording medium in accordance with digital data signals. A droplet is not formed or expelled unless it is to be placed on the recording medium.

Although the main effort in this invention is directed towards images of high quality recorded by the continuous stream system it is not meant to be restricted to this method, but is applicable as well to images recorded by drop-on-demand systems (e.g. thermal ink-jet or piezo ink-jet).

Ink-jet printers often use inks that contain water soluble dyes. Such dyes are often not very smear resistant when printed on ink receiving sheets. The smear resistance of water based inks may be improved by the addition of formamide (US 4,961,785), pyrrolidones (US 5,108,503), ammonium zirconium polymer salt (US 5,250,107), and the like.

Often such modifications of the inks have the tendency to give inks liable to show precipitates upon prolonged storage. Such precipitates subsequently tend to clog the nozzles of ink-jet printers.

Ecological and toxicological reasons also do not recommend the use of such modified inks: The solvents used in such modified inks increase the solvent content in the air near the ink-jet printer and therefore sophisticated and costly installations may be required to remove the solvent containing air in the ink-jet printer surroundings so as to stay within legal limits for the solvent content in the air.

The use of such solvents with a high boiling point also slows down the drying of the printed ink receiving sheets, eventually needing supplementary drying, for example microwave drying as described in EP 0,559,324.

Another attempt to improve smudge resistance has been the use of reactive dyes, as for instance in US 4,443,223, US 5,098,475, US 5,074,914, US 5,230,733, EP 0,429,171 and references cited therein. These reactive dyes have a reactive moiety attached to the chromophore and are capable of forming a covalent bond to one or more of the components of the receiving layers of the ink receiving sheet. Although some improvement has been achieved by this technique no satisfactory results can in general be obtained due to the fact that the conditions which are possible in practice in a printing

environment do not suffice to achieve reaction of these dyes with given binders.

There is a need to produce high quality ink-jet generated images and one method of achieving this is to use coated papers as the image receiving sheet and for example, gelatin is a useful coating for such sheets. However, it is difficult to get the dyes in the inks used to penetrate the surface of such coated papers and not to remain on the surface from which they are easily removed in smearing the image.

It would therefore be much preferred if the improved smudge resistance could be achieved by a modification of the ink receiving sheets or a post-treatment of already printed images.

Such a post-treatment would be the method of choice as it would be applicable to a wide variety of inks and ink receiving sheets and combinations thereof.

It is well known that even a gentle contact of the surface of a printed ink receiving sheet with water (for example with a wet finger) mobilises the dyes deposited at the surface. These dyes subsequently are easily moved mechanically to adjacent parts of the image. If water flows for a short time over the surface of a printed ink receiving sheet it carries the surface dye with it. This dye is later deposited at another place of the sheet.

It was therefore totally unexpected that the treatment of printed ink receiving sheets with steam should lead to a dramatic improvement in smudge resistance. Rubbing of such treated ink receiving sheets with a wet finger leaves the ink receiving sheets totally or nearly unaltered. Also water flowing over the surface no longer carries the surface dye with it. When looking

under a low angle at the image no more surface dye is seen after the treatment. The resulting image looks much more pleasant.

An objective of this invention therefore is to provide a simple post-printing treatment of ink receiving sheets to improve smudge resistance.

According to the present invention there is provided a method of treating a coated ink receiving sheet after it has been ink printed which comprises directing on to the ink receiving sheet a stream of steam at a temperature of 100°C or over and for between 0.1 to 100 seconds under such conditions that only minimum condensation of water occurs on the surface of the ink receiving sheet.

Thus it is to be understood that the temperature of the steam, the length of time the steam is directed on to the printed ink receiving sheet and the distance of the means for directing the steam on to the printed ink receiving sheet must be arranged relative to each other so that only minimum condensation of water from the steam on the ink receiving sheet occurs.

Preferably in the method of the present invention the temperature of the steam is from 100 to 120°C.

Preferably in the method of the present invention the steam is directed on to the ink receiving sheet from 0.1 to 10 seconds.

In one method of the present invention the treatment with steam is carried out off-line. That is to say after the ink receiving sheet is ink printed and dried, the ink receiving sheet is treated with steam in a separate treating means.

However, in another method of the present invention the treatment with steam is carried out on-line a short time after the ink receiving sheet has been ink printed and before the ink receiving sheet has dried completely.

Preferably the ink receiving sheet which comprises the image is heat-treated after the steam treatment.

Therefore in the preferred method of the present invention there is provided a method of treating a coated ink receiving sheet after it has been ink printed which comprises directing on to the ink receiving sheet a stream of steam at a temperature over 100°C and for between 0.1 and 100 seconds under such conditions that minimum condensation of water occurs on the surface of the ink receiving sheet and then directing heat on to the sheet for between 0.1 and 100 seconds so that the surface temperature of the sheet is between 60°C and 150°C.

Preferably the steam and the heat are directed on to the sheet for between 0.1 and 10 seconds.

Preferably the heating means is a convection heater or is a radiant heater for example an infra-red radiant-heater.

Preferably the sheet is subjected to two heaters each arranged over the path of the sheet.

Preferably in the method of the present invention the steam generating means comprises a steam inlet tube, the open end of which is located in an insulated steam jacket with a slot or arrangement of slots outlet. Most preferably a heater is provided in the steam jacket to eliminate the risk of water

condensing from the steam prematurely. The temperature in the steam jacket can be raised so that super-heated steam is produced.

Preferably in the method of the present invention the chamber which comprises the heater or heaters also comprises a fan which directs air heated by the heater or heaters on to the sheet being conveyed beneath.

Most conveniently the first heater is located as close as is possible to the steam chamber so that after the sheet has been steam treated it is at once dried at an elevated temperature.

The method of the present invention can be used to treat sheets of paper or rolls of paper which have been ink-jet printed.

The following Example will serve to illustrate the method of the present invention.

Example

The coated ink receiving sheets were prepared according to Example 7 of our pending patent application PCT/GB95/00784. The coated layers on a glossy RC paper support had the following compositions:

First coated layer on to resin coated paper (RC paper):

Gelatin with high isoelectric point	3.750 g/m²
Lanthanum nitrate	0.300 g/m²
Olin 10G (wetting agent)	0.125 g/m²

Second layer on top of the first layer:

Gelatin with high isoelectric point	3.750 g/m²
Spacing agent	0.100 g/m²
Olin 10G (wetting agent)	0.150 g/m²
2-(4-dimethylcarbamoylpyridino)-ethanesulfonate (Cross linker)	0.033 g/m²

Olin 10G is available from Olin Chemicals, USA.

Three series of sheets were ink printed in an Iris 3024 ink-jet printer with ID inks both available from Iris Graphics Inc, USA, and then treated as just described. These sheets were compared with similar sheets which after ink printing were cold air dried.

In the series, steam when applied was applied for 2 seconds and heat when applied was for 2 seconds to yield a surface temperature of 120°C.

In the first series the sheets were treated to both steam and then heat.

In the second series the sheets were subjected to steam treatment and were then allowed to be cold air dried.

In the third series the sheets were heat treated only, that is to say no steam treatment was used.

The treated sheets of the first, second and third series and the untreated sheets were all tested for smudge resistance and for gloss.

For the smudge test maximum density dye patches on the sheets were gently rubbed with a wet finger and whether dye smudging occurred or not was noted.

Gloss measurements were done as specified in DIN norm 67,530 (January 1982) for the angles 20°, 60° and 85° on colour patches of 70% of maximum density or on white patches on the treated and on the non-treated sheets.

Table 1 shows the results of the smudge test

Table 1

Sheets tested	Ink smudging
Series 1 sheets	No
Untreated sheets	Yes
Series 2 sheets	No
Series 3 sheets	Yes

This shows that steam treatment is required to obviate dye smudging.

Table 2 shows the results of the gloss measurements.

Table 2

Sheets Tested	Area Tested	Gloss		
		20°	60°	85°
Untreated	Black	32.1	61.9	38.0
	White	36.3	38.8	24.6
	Magenta	33.5	61.2	33.9
First Series	Black	51.3	67.0	55.1
	White	52.3	65.3	43.6
	Magenta	40.8	62.2	53.8
Second Series	Black	28.6	61.7	38.7
	White	33.5	58.3	23.8
	Magenta	30.5	60.7	34.9
Third Series	Black	28.6	61.7	38.7
	White	33.5	58.3	23.8
	Magenta	30.0	60.7	34.9

These results show that when the sheets had been treated both with steam followed by heat (first series) a greatly improved gloss is obtained compared with the untreated sheets.

However, when the sheets had been steam treated only not followed by heat treatment (second series) no improvement in gloss was obtained.

The results also show that when the sheets were heat treated without the prior steam treatment (third series) no improvement in gloss was obtained.

Claims:-

1. A method of treating a coated ink receiving sheet after it has been ink printed which comprises directing on to the ink receiving sheet a stream of steam at a temperature of 100°C or over and for between 0.1 to 100 seconds under such conditions that only minimum condensation of water occurs on the surface of the ink receiving sheet.

2. A method according to claim 1 wherein the temperature of the steam is between 100 and 120°C.

3. A method according to claim 1 wherein the steam is directed on to the ink receiving sheet from 0.1 to 10 seconds.

4. A method according to claim 1 wherein the treatment with the steam is carried out off-line.

5. A method according to claim 1 wherein the treatment with the steam is carried out on-line a short time after the ink receiving sheet has been ink printed.

6. A method of treating a coated ink receiving sheet after it has been ink printed which comprises directing on to the ink receiving sheet a stream of steam at a temperature 100°C or over and for between 0.1 and 100 seconds under such conditions that only minimum condensation of water occurs on the surface of the ink receiving sheet and then directing heat on to the sheet for between 0.1 and 100 seconds so that the surface temperature of the sheet is between 60°C and 150°C.

7. A method according to claim 6 wherein both the steam and the heat are directed on to the receiving sheet for between 0.1 and 10 seconds.

8. A method according to claim 6 wherein the heating means is a convection heater or is a radiant heater.

9. A method according to claim 8 wherein the heater is an infra-red radiant heater.

10. A method according to claim 9 wherein the sheet is subjected to two infra-red heaters each arranged over the path of the sheet.

11. A method according to claim 10 wherein the first heater is located as close as is possible to the steam chamber so that after the sheet has been steam treated it is at once dried at an elevated temperature.

INTERNATIONAL SEARCH REPORT

International Application No
PC./GB 95/02517

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B41M7/00 B41J2/17

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B41M B41J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	DE,A,32 09 475 (MOHNDRUCK REINHARD MOHN OHG) 29 September 1983 see the whole document	1-11 1-11
X	DE,A,34 34 875 (METEOR SIEGEN APPARAT SCHMECK) 3 October 1985 see the whole document	1-11
X	DE,B,27 59 666 (REINHARD MOHM GMBH) 7 May 1981 see the whole document	1-4
X	DE,C,691 323 (INTERCHEMICAL CORPORATION) 14 January 1936 see the whole document	1
Y	DE,A,34 17 376 (CANON KK) 15 November 1984 see the whole document	1-11

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 March 1996	04. 04. 96

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	Rasschaert, A

Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	PATENT ABSTRACTS OF JAPAN vol. 006 no. 213 (M-167) ,26 October 1982 & JP,A,57 120447 (MATSUSHITA DENKI SANGYO KK) 27 July 1982, see abstract	8,9,11
A	US,A,2 157 388 (INTERCHEMICAL CORPORATION) 9 May 1939 see the whole document	1
A	GB,A,549 235 (MICHIGAN RESEARCH LABORATORIES) 12 November 1942 see the whole document	1
A	PATENT ABSTRACTS OF JAPAN vol. 017 no. 655 (C-1136) ,6 December 1993 & JP,A,05 209380 (CANON INC) 20 August 1993, see abstract	1

INTERNATIONAL SEARCH REPORT

nformation on patent family members

Inte onal Application No
PC /GB 95/02517

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE-A-3209475	29-09-83	NONE	
DE-A-3434875	03-10-85	NONE	
DE-B-2759666	07-05-81	NONE	
DE-C-691323		NONE	
DE-A-3417376	15-11-84	JP-A- 59209147 JP-A- 59209148 GB-A,B 2142579	27-11-84 27-11-84 23-01-85
US-A-2157388	09-05-39	NONE	
GB-A-549235		NONE	